Tobacco Smuggling in Canada, the Demand for "Nico" Dollars, and the Size of the Underground Economy

Maxime Fougère*

PRÉCIS

Étant donné que par sa nature, l'économie souterraine est une activité cachée, elle échappe presque aux tentatives d'évaluer sa taille et sa croissance. La méthode la plus couramment utilisée pour estimer sa taille est l'approche monétaire de la demande de billets en circulation. La plus grande incertitude avec cette approche est l'hypothèse au sujet du montant des espèces utilisé par dollar de revenu non rapporté. La plupart des chercheurs qui utilisent cette approche ont posé l'hypothèse selon laquelle le ratio du revenu sur numéraire dans une économie souterraine est la même que la vélocité de la monnaie pour l'agrégat monétaire M1 dans l'économie rapportée. Dans cette étude, nous utilisons l'épisode récente de la croissance rapide de la contrebande de tabac au Canada comme expérience naturelle nous permettant d'explorer le rapport entre la contrebande de tabac et la demande de billets en circulation. Nous estimons aussi le ratio du revenu sur numéraire dans ce secteur de l'économie souterraine et évaluons la sensibilité de la contrebande de tabac à un changement du prix relatif du tabac. Les résultats indiquent qu'en 1993, la demande de numéraires associée à la contrebande de tabac atteignait jusqu'à 2,6 pour cent de la demande totale de billets en circulation au Canada. Le ratio du revenu sur numéraires est aussi très bas, suggérant un haut degré de thésaurisation dans ce secteur. Les résultants indiquent qu'une hausse de 1 pour cent du prix relatif du tabac au Canada stimulerait la consommation de tabac de contrebande d'environ 2,6 pour cent. En conclusion, nous soutenons que la plupart des études qui ont utilisé l'approche de la demande de billets en circulation ont probablement surestimé l'importance de l'activité souterraine en utilisant une valeur trop élevée pour le ratio du revenu sur numéraire.

* Of Human Resources Development Canada. The views expressed in the article are solely those of the author. No responsibility for them should be attributed to Human Resources Development Canada. The author also wishes to thank G.C. Ruggeri, Arndt Vermaeten, and two anonymous referees for useful comments.

ABSTRACT

Because of its hidden nature, the underground economy almost defies attempts to assess its size and growth rate. The most commonly used method to estimate its size is the currency demand approach. The greatest uncertainty with this approach is the assumption about the amount of currency used per dollar of unreported income. Most researchers who use this approach have assumed that the ratio of income to cash in an underground economy is the same as the income velocity of the monetary aggregate M1 in the above-ground economy. In this article, we use the recent episode of the rapid growth in tobacco contraband in Canada as a natural experiment that allows us to explore the relationship between tobacco smuggling and the demand for currency. We also estimate the income-to-cash ratio in that sector of the underground economy and assess the sensitivity of tobacco smuggling to a change in the relative price of tobacco. The results indicate that in 1993 the demand for cash associated with tobacco contraband represented up to 2.6 percent of the total currency demand in Canada. The income-to-cash ratio is also fairly low, suggesting a high degree of currency hoarding in that sector. These findings indicate that a 1 percent rise in the relative price of Canadian tobacco would stimulate the consumption of contraband tobacco by about 2.6 percent. In conclusion, we argue that most studies that use the currency demand approach probably overstate the importance of underground activity by using too high a value of the income-to-cash ratio.

INTRODUCTION

The size and the rate of growth of the underground economy remain questions of considerable interest for governments and the public in general. A large and growing underground economy can have serious economic and fiscal implications: it can erode the tax base and cause important measurement errors in official economic statistics.

Because of its hidden nature, the underground economy is very difficult to measure. A number of direct and indirect methods have produced a wide range of estimates.[1] Studies based on household surveys or on sensitivity analyses of

1 For examples of the various approaches, see Mireille Éthier, "The Underground Economy: A Review of the Economic Literature and New Estimates for Canada," in François Vaillancourt, research coordinator, *Income Distribution and Economic Security in Canada*, Collected Research Studies of the Royal Commission on the Economic Union and Development Prospects for Canada, vol. 1 (Toronto: University of Toronto Press, 1985), 77-104; Edgar L. Feige, "The Meaning and Measurement of the Underground Economy," in *The Underground Economy: Tax Evasion and Information Distortion* (Cambridge: Cambridge University Press, 1984); and Derek Blades, "The Hidden Economy in the National Accounts" [June 1982], *OECD Economic Outlook: Occasional Studies* 28-45.

the components of gross domestic product (GDP)[2] tend to provide lower estimates of the size of the underground economy. But measures based on currency demand and the transaction approach usually give higher estimates (see appendix A, tables A.1 and A.2).

Among these methods, the econometric estimation of a currency demand equation is the most commonly used. This method's key underlying assumption is that currency is the exclusive medium of exchange in an unreported transaction. Although this approach is popular, it has been criticized on various grounds.[3] Of all the objections to this method, the one causing the greatest uncertainty is the assumption about the amount of currency used per dollar of unreported income.[4] This assumption is necessary to convert the amount of cash used in an underground economy to an estimate of unreported income. But there has been no relevant theory that could be used to assess the value of the income-to-cash ratio in an underground economy, and the use of empirical methods appears even more problematic.

There may be an exception to this problem, however. The episode of the rapid growth in tobacco contraband in Canada, over the period 1987 to 1993, offers a natural experiment for exploring the relationship between tobacco contraband and the demand for cash. Strong evidence suggests that a large proportion of the tobacco products smuggled into Canada over that period had been previously manufactured in and exported from Canada.[5] Statistics Canada, for example, in its annual revision of the National Income and Expenditure Accounts (NIEA) of June 1994,[6] used information from tobacco exports to measure the value of illegal tobacco imports and personal expenditures on contraband cigarettes. As a result,

---

2 For examples of this method, see Seymour Berger, "The Unrecorded Economy: Concepts, Approach and Preliminary Estimates for Canada, 1981," in *Canadian Statistical Review, April 1986*, Statistics Canada catalogue no. 11-003, 1-125; and Gylliane Gervais, *The Size of the Underground Economy: A Statistics Canada View*, Statistics Canada catalogue no. 13-603E, no. 2 (Ottawa: Statistics Canada, 1994).

3 For more detailed discussions on the approach, see Roderick Hill and Muhammed Kabir, "Tax Rates, the Tax Mix, and the Growth in the Underground Economy in Canada: What Can We Infer?" (1996), vol. 44, no. 6 *Canadian Tax Journal* 1552-83; Don Drummond, Mireille Éthier, Maxime Fougère, Brian Girard, and Jeremy Rudin, "The Underground Economy: Moving the Myth Closer to Reality" (1994), vol. 2, no. 4 *Canadian Business Economics* 3-17; Friedrich Schneider, "Can the Shadow Economy Be Reduced Through Major Tax Reform? An Empirical Investigation for Austria" (1994), vol. 49, supplement *Public Finance* 137-48; and Jan Tore Klovland, "Tax Evasion and the Demand for Currency in Norway and Sweden: Is There a Hidden Relationship?" (1984), vol. 86 *Scandinavian Journal of Economics* 423-39.

4 This is namely the inverse of the income velocity of currency in the underground economy.

5 See Lindquist Avey Macdonald Baskerville Inc., "Contraband Tobacco Estimates" (Toronto, 1992).

6 See Gervais, supra footnote 2.

Statistics Canada claims to provide a reliable estimate of the impact of tobacco smuggling on GDP. Anecdotal evidence also suggests that most transactions in tobacco smuggling are cash based. If we can estimate the effect of tobacco smuggling on the demand for currency—that is, the demand for "tobacco dollars" ("nico" dollars)—we can also approximate the income-to-cash ratio in that sector of the underground economy and assess the sensitivity of tobacco smuggling to a change in the relative price of tobacco. Moreover, the estimate of the income-to-cash ratio in tobacco contraband can help to provide a benchmark for the income-to-cash ratio in the overall underground economy.

In this article, we examine the impact of tobacco contraband in Canada on the demand for currency. We estimate an econometric equation of the demand for currency, and use the price of tobacco products in Canada relative to the United States (denominated in Canadian dollars) to capture the effect of tobacco smuggling on the demand for currency. We also use this measure to calculate the value of the income-to-cash ratio in tobacco contraband and to estimate the sensitivity of tobacco smuggling with respect to a change in tobacco prices.

First, we summarize the currency demand approach to assessing the underground economy. Then we discuss the episode of the rapid expansion in tobacco contraband in Canada over the period 1987 to 1993. Finally, we present some empirical results on a currency demand equation, the demand for "nico" dollars in Canada, and the income-to-cash ratio in tobacco contraband, followed by some concluding remarks.

THE CURRENCY DEMAND APPROACH

Background

The currency demand approach assumes that, to avoid leaving observable traces for the authorities, transactions in the underground economy occur in the form of cash payments. According to this assumption, an increase in the size of the underground economy will raise the demand for currency. This assumption is based on the original work of Cagan, who argued that an increase in the tax burden would lead to an increase in tax evasion and thus raise the demand for cash.[7]

Guttman was the first to use data on currency circulation for the United States to estimate the size of the underground economy. He assumed that the ratio of currency to demand deposit (the Cu/Dd ratio) was influenced only by changes in the tax burden.[8] He also assumed that the Cu/Dd ratio that prevailed in 1937 was normal and that the increase in the Cu/Dd ratio between 1937 and 1976 was due

7 Phillip Cagan, "The Demand for Currency Relative to the Total Money Supply" (1958), vol. 66, no. 4 *The Journal of Political Economy* 303-28.

8 Peter M. Guttman, "The Subterranean Economy" (November-December 1977), 33 *Financial Analysts Journal* 26-27.

to the rise in the underground economy. Guttman's simple approach was criticized for not accounting for the effect of financial innovations and other economic factors that might also have affected the Cu/Dd ratio.

Tanzi used an econometric method to estimate the demand for currency.[9] In addition to the typical economic variables, and following Cagan,[10] he included alternative measures of the tax burden to explain the demand for currency. He also assessed the size of the US underground economy. Tanzi's work was followed by numerous studies that used the currency demand approach to estimate the size of the underground economy for various countries.

Summary of the Approach

The currency demand approach estimates the size of the underground economy in two steps: The first is to estimate the demand for cash that is used in the underground economy (we might call this "illegal" money). The second is to convert this measure to an estimate of the amount of unreported income.

The Demand for Currency in the Underground Economy

For the first step, we estimate econometrically a currency demand equation, controlling for potential above-ground determinants such as income, interest rates, and inflation. We suppose that the demand for cash in excess of these conventional determinants is due to an expansion in the underground economy. Additional factors, such as an increase in the tax burden, regulation, or a more negative attitude toward taxation, may encourage growth in the underground economy and explain the "excess" demand for cash. Most studies have used only alternative tax rate measures to explain the change in the underground economy.[11]

Then we set the determinants of the underground economy (for example, the tax rates) to their base-year level, thereby estimating the change in the currency demand associated with the rise in the underground economy since the base year. The difference between the total demand for cash and the estimated demand in the above-ground economy provides an estimate of the change in the demand for currency in the underground economy since the base year.

---

9 Vito Tanzi, "The Underground Economy in the United States: Estimates and Implications" (December 1980), 135 Banca Nazionale del Lavaro *Quarterly Review* 427-53; and "The Underground Economy in the United States: Annual Estimates, 1930-1980" (1983), vol. 30, no. 2 *International Monetary Fund Staff Papers* 283-305.

10 Supra footnote 7.

11 There is at least one notable exception. In addition to tax variables, Schneider added a measure of the visibility of the tax system and of the intensity of regulation to estimate the size of the Austrian underground economy (Schneider, supra footnote 3; and Friedrich Schneider, "Further Empirical Results of the Size of the Shadow Economy of 17 OECD Countries Over Time," paper presented at the Canadian Public Economics Study Group, May 27, 1998, Ottawa). All variables were found to be statistically significant.

The Income-to-Cash Ratio in the Underground Economy

The second step is to convert the amount of "illegal" money to an estimate of unreported income. We must make an assumption about the income-to-cash ratio in the underground economy to come up with an estimate of unreported income. As mentioned in the introduction, however, considerable uncertainty surrounds the value of this income-to-cash ratio.

Discussion

Cagan[12] used, as his income-to-cash ratio, the ratio of annual personal disposable income to total personal money balance, excluding incorporated businesses. This ratio had a value of 1.84 in 1940 and 1.96 in 1950 for the United States. He based his choice for this measure on the following assumption: "b) the amount of currency so used per dollar of income is not less than the amount of money used per dollar of all income."[13] But Cagan also added:

> [I]t is likely that assumption b is far too conservative and that the amount of money held against a dollar of unreported income is much greater, on the average, than the amount of money held against a dollar of regular income. Unreported income produces an abnormal demand for currency to hoard.[14]

Tanzi[15] assumed that the relationship between illegal money and unreported income is the same as the ratio of legal money holdings (defined as currency plus demand deposit—M1—minus illegal money) to measured gross national product (GNP). This value was 5.9 in 1976. Tanzi admitted, however, that "the assumption that the income velocity of money is the same in the underground and in the legal economy is a crucial one. It is the result of agnosticism."[16]

Following Tanzi, most studies that estimated the size of the underground economy with the currency demand approach made a similar assumption concerning the value of the income-to-cash ratio. But some papers were more critical of this assumption and made alternative suggestions.

From Cramer's calculations[17] on the transaction velocity of currency circulation in the Netherlands, Klovland estimated that the income velocity of currency in the regular economy was slightly below 3.[18] Klovland also argued that because

12 Supra footnote 7.

13 Ibid., at 315.

14 Ibid.

15 Supra footnote 9.

16 "The Underground Economy in the United States: Estimates and Implications," supra footnote 9, at 449.

17 J.S. Cramer, "The Work Money Does: The Transaction Velocity of Circulation of Money in the Netherlands, 1950-1978" (1981), vol. 15, no. 3 *European Economic Review* 307-26.

18 Klovland, supra footnote 3.

of the presumably greater degree of currency hoarding in the underground economy, on the one hand, the income-to-cash ratio could be lower than in the official sector. But on the other hand, because services probably constitute a relatively large fraction of unreported activity, the final price should consist mostly of value added within the sector. That would likely imply a greater income-to-cash ratio. Finally, because of the great uncertainty surrounding this measure, he used four alternative values of the income-to-cash ratio, from 2 to 7, to convert the estimated demand for cash in the underground economy for Sweden to an estimate of unreported income.[19]

Laflèche reviewed the various "monetary" methods to estimate the size of the underground economy and in particular the econometric estimation of the demand for currency.[20] In her discussion about the estimation of the income-to-cash ratio in the underground economy, Laflèche argues that using the income velocity of cash, or even M1, as an estimate of a measure of the income-to-cash ratio is debatable. Cash is not the primary means of payment in the official economy, and M1 does not include all means of payment. Chequable savings deposits must also be included, implying that the income-to-cash ratio in the underground economy would be lower than the income velocity of M1.

She also argues that, if part of the currency circulation in the underground economy is used for savings purposes, then one should use a monetary aggregate that includes not only chequable deposits but also savings deposits. In that case, the income-to-cash ratio could be much lower than the income velocity of M1. But since there is great uncertainty about the extent of saving in the underground economy, and since keeping large amounts of cash is impractical, perhaps less hoarding occurs in the underground economy than in the official one. Thus the income-to-cash ratio in the underground economy might be greater than the velocity of very broad monetary aggregates, such as M2+,[21] which includes, in addition to M1, all personal and non-personal savings deposits in banks and near banks.

Drummond et al.,[22] following a similar argument to Laflèche's, support the use of a broader monetary aggregate than M1 to estimate the income-to-cash

19 Hill and Kabir, supra footnote 3, used the same range as Klovland to estimate the change in the underground economy in Canada since 1965.

20 Thérèse Laflèche, "The Demand for Currency and the Underground Economy" [Autumn 1994] *Bank of Canada Review* 39-53.

21 Total M2 is equal to M1 plus personal savings deposits and non-personal notice deposits. M2+ is equal to M2 plus trust and mortgage loan companies, credit unions and caisses populaires, life insurance companies, individual annuities, personal deposits at government-owned institutions, and money market mutual funds. The income velocity of M1, M2, and M2+ reached 10.5, 2, and 1.4, respectively, in 1999.

22 Drummond et al., supra footnote 3.

ratio in the underground economy. They argue that, by using the income velocity of M1, most researchers probably overestimate the size of the underground economy using the currency approach.

Spiro also claims that the velocity of M1 is likely to overestimate seriously the income-to-cash ratio in the underground economy, because it does not include all means of payment.[23] Spiro looks at the income velocity of M1 in Canada, over the period 1926 to 1959, which preceded the large development of banking services. It averaged 5.4 over that period and increased sharply after 1960. As a result, he chooses the value of 5 for the income-to-cash ratio to estimate the size of the underground economy. However, as pointed out by Laflèche[24] and Drummond et al.,[25] Spiro ignores the possibility that cash is also likely to be used as a store of value in the underground economy.

Clearly, the assumption regarding the value of the income-to-cash ratio in the underground economy is critical, and the uncertainty surrounding this measure greatly reduces our ability to rely on the currency approach to assess the underground economy. If we could make an empirical estimate of the income-to-cash ratio in the underground economy or in some sector of underground activity, we could better narrow the band on the value of the income-to-cash ratio.

Thus in the next sections, we discuss the emergence of tobacco contraband in Canada and examine its impact on the demand for cash.

TAXATION AND TOBACCO SMUGGLING IN CANADA

In Canada, both federal and provincial governments collect taxes on tobacco products. At the federal level, tobacco products sold in Canada are subject to an excise tax and duty. A customs duty is also levied on imported tobacco products. Finally, the sale and importation of tobacco products are subject to the goods and services tax (GST).[26] At the provincial and territorial levels, tobacco products are subject to the retail sales tax as well as to a special tax, levied on a per unit or an ad valorem basis. Also, since 1994 a tax has applied to exported cigarettes for tobacco companies that export more than 1.5 percent of their production. Finally, exported Canadian cigarettes are subject to the US excise tax and to other state and US municipal consumption or retail sales taxes.

Beginning in the early 1980s, both the federal and the provincial governments substantially raised tobacco taxes. The objective was twofold: to increase revenues

23 Peter S. Spiro, "Estimating the Underground Economy: A Critical Evaluation of the Monetary Approach" (1994), vol. 42, no. 4 *Canadian Tax Journal* 1059-81.

24 Supra footnote 20.

25 Supra footnote 3.

26 The GST was implemented in January 1991 to replace the existing federal sales tax (FST). Before the GST implementation, tobacco sales were taxable under the FST.

to help fight growing budget deficits, in the short run, and to raise tobacco prices to discourage smoking, in the longer run. As a result, tobacco prices rose about 72 percent relative to US tobacco prices between 1982 and 1991 (see figure 1).

The increase in the relative price of tobacco was followed by a drop in both the production and the legal consumption of tobacco products (see figure 2). Part of the decline in legal consumption can be explained by a reduction in the number of smokers. However, the sharp increase in the price of tobacco also encouraged the expansion of tobacco contraband with the United States.[27] As shown in figure 2, the legal consumption of tobacco products fell more than production did, and exports increased sharply.

In fact, Canadian cigarettes, manufactured and exported legally, were being smuggled back into the country.[28] According to various sources,[29] about 90 percent of the cigarettes smuggled over that period had been legally manufactured in Canada. Gervais[30] estimated the contraband sales of cigarettes produced in Canada over the period 1986 to 1993. The difference between the normal volume and the actual volume of exports constitutes the estimated volume of contraband cigarettes entering the country. Her results are reproduced in table 1.[31]

According to her estimates, contraband sales remained marginal in 1987 and 1988, but grew rapidly between 1989 and 1993. From only 1.0 percent in 1987, the market share of tobacco contraband rose to almost 31 percent in 1993 and was still growing by year end. According to Drummond et al.,[32] the estimated revenue loss to the federal government amounted to between $1 billion and $1.2 billion for fiscal years 1992-93 and 1993-94. Provincial governments lost equivalent amounts in revenue during that period.

In response to the flourishing trade in tobacco contraband, the federal government declared war on tobacco smuggling in February 1994 and announced an antismuggling program. Among other measures, the federal government reduced the tax on cigarettes by $5 per carton and promised to match any provincial cuts of more than $5, to a maximum of another $5. Provincial tobacco tax cuts followed in Quebec, Ontario, New Brunswick, Nova Scotia, and Prince Edward Island. Following the tobacco tax cuts, prices fell 40 percent relative to the total

---

27 In addition, the value of the Canadian dollar appreciated significantly relative to the US dollar over that period, which also increased the markup on smuggled cigarettes and created more incentives for contraband.

28 The Canadian and US governments suspect that Canadian-based tobacco companies were involved in the organization of smuggling activities.

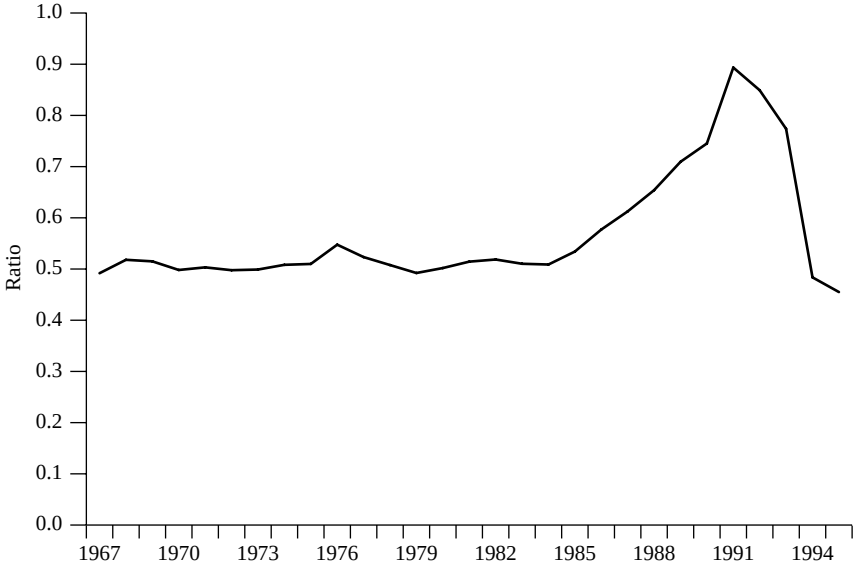
29 See, for example, Lindquist Avey Macdonald Baskerville Inc., supra footnote 5; and Lindquist Avey Macdonald Baskerville Inc., "Contraband Tobacco Estimate—and Update" (Toronto, 1993).

30 Supra footnote 2.

31 This estimate does not account for contraband cigarettes produced outside Canada.

32 Supra footnote 3.

Figure 1 Canada-US Relative Consumer Price Index for Tobacco Products



Sources: Statistics Canada, *The Consumer Price Index*, catalogue no. 62-001; and United States, Department of Labor, *CPI Detailed Report* (Washington, DC: US Government Printer, various years).

consumer price index (CPI) and 44 percent relative to tobacco prices in the United States (denominated in Canadian dollars).[33] As figure 2 shows, this policy appears to have been effective, since exports of cigarettes fell sharply in 1994, and the legal consumption of tobacco products returned to its 1989 level.[34]

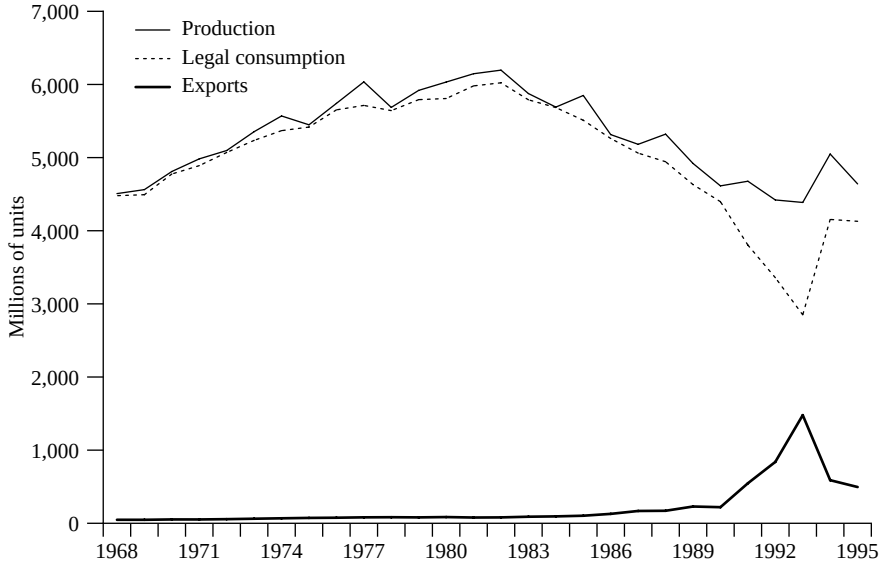
Gervais also estimated the impact of underground transactions related to tobacco smuggling on GDP for 1992 and 1993. According to her original estimate, personal expenditures in tobacco contraband amounted to $1.06 billion and $1.90 billion in 1992 and 1993, respectively. However, since smuggled tobacco was imported from the United States, the impact on net income and GDP was much smaller. According to Gervais, "These estimates are reliable and can be considered complete."[35]

33 The federal government also imposed an export tax on exported cigarettes in the early 1990s as an antismuggling measure. However, it eliminated the tax shortly after, following heavy complaints from tobacco companies. The government reimposed the export tax in 1994, after cutting domestic tobacco taxes.

34 More recently, tobacco taxes have increased in the United States, permitting Canadian federal and provincial governments to raise tobacco taxes again gradually, without encouraging tobacco contraband.

35 Gervais, supra footnote 2, at 24.

Figure 2 Legal Consumption, Exports, and Production of Tobacco Products in Canada



Source: Statistics Canada, *Production and Disposition of Tobacco Products*, catalogue no. 32-022.

EMPIRICAL EVIDENCE ON THE DEMAND FOR CURRENCY

In this section, we estimate the demand for currency in Canada. The model is based on the conventional theory of transaction demand for money. According to the model, the demand for real money balances depends positively on real income or expenditures and negatively on interest rates and the rate of inflation. The interest and inflation rates represent the opportunity cost of holding money relative to bonds and equity. In addition, to capture the effect of tax evasion, it is assumed that the demand for currency also depends on the rate of taxation. We incorporate three variables to capture the effect of taxation on the demand for cash: a measure of direct personal taxation, a measure of indirect taxation, and the relative price of tobacco products.[36] The third variable represents the incentive effect to tobacco contraband. The model has the following general form:

$$Cu / P = f(Cu_{(-1)} / P_{(-1)}, Y, r, \dot{P}, \tau_D, \tau_I, P_T^C / eP_T^{US}) \qquad (1)$$

where Cu is currency, P is the consumer price deflator, Y is real personal disposable income, r is the 90-day commercial paper rate, τ_D is the burden of total

36 For a more detailed analysis on the relationship between taxes and the growth in the underground economy, see Hill and Kabir, supra footnote 3.

Table 1 Legal Sales and Estimated Contraband Sales of Canadian Cigarettes, by Volume

	1986	1987	1988	1989	1990	1991	1992	1993
				billions of cigarettes				
Legal sales	63.6	61.1	60.3	56.4	52.9	46.7	41.3	34.8
Estimated contraband sales	0.0	0.6	0.6	1.3	1.8	6.6	9.8	15.6
Total sales	63.6	61.7	60.9	57.7	54.7	53.3	51.1	50.4
				percent				
Market share of contraband	0.0	1.0	1.0	2.3	3.3	12.4	19.2	31.0

Source: Gylliane Gervais, *The Size of the Underground Economy: A Statistics Canada View*, Statistics Canada catalogue no. 13-603E, no. 2 (Ottawa: Statistics Canada, 1994).

direct personal taxation, τ_I is the burden of total indirect taxation, P_T^C and P_T^{US} are Canadian and US CPI for tobacco products, e is the Canada-US exchange rate, and the "dot" notation represents the rate of change of the variable.

According to Gervais,[37] Statistics Canada revised the value of consumption and income in the NIEA to account for spending on smuggled cigarettes. Therefore, ideally we should use a measure of disposable income that excludes smuggling income in the regression. However, the value of the net smuggling income associated with tobacco contraband represented only about 0.1 percent of personal disposable income in 1993, and its contribution to growth in that year represented 0.03 percentage points, which is quite negligible. As a result, the exclusion or inclusion of smuggling income in personal disposable income has no effect on the results.

As in Schneider,[38] the burden of total direct personal taxation, τ_D, includes the sum of both the average effective (including employee and employer payroll taxes) and the average marginal personal income tax rates.[39] The rate of indirect taxation is total indirect taxes as a share of total consumption.

It is not clear, however, that the indirect tax rate variable can fully capture the likely effect of the introduction of the GST in 1991 on the underground economy.[40] There was strong popular opposition to the implementation of the GST, and according to Flexman a significant proportion of the population found it

37 Supra footnote 2.

38 Supra footnote 3.

39 The average marginal personal income tax rate is weighted by total income. The calculation of this rate is based on the method of James B. Davies and Junsen Zhang, "Measuring Marginal Income Tax Rates for Individuals in Canada: Averages and Distributions over Time" (1996), vol. 29, no. 4 *Canadian Journal of Economics* 959-75.

40 Peter S. Spiro, "Evidence of a Post-GST Increase in the Underground Economy" (1993), vol. 41, no. 2 *Canadian Tax Journal* 247-58, argues that the introduction of the GST has contributed to the rise in the underground economy.

morally acceptable to evade that tax.[41] In addition, in contrast to the old federal sales tax, the GST is not included in the product price and is thus more visible. This visibility facilitates tax evasion, inviting collusion between buyers, who save the GST, and sellers, who save the income tax, especially in the case of services. To fully capture the effect of the GST, therefore, we include a dummy variable in the model, $Dummy_{GST}$, which is equal to 1 from the beginning of 1991 and to 0 before 1991.

It can be shown that most time-series variables have non-stationary tendencies (unit roots). To test for the presence of a unit root, we have applied the augmented Dickey-Fuller and the Phillip-Perron tests on all the series. According to the results (available on request), both tests are consistent with the hypothesis that the series are non-stationary in level (or log-level) but stationary in first difference. Non-stationarity can lead to spurious correlation among the variables. To avoid this potential problem, we estimate the currency demand equation in first differences. We also allow for the possibility of a lagged relationship between the explanatory and dependent variables. The number of lags used in the estimated equation is based on the Akaike's information criteria. We use quarterly variables for the period 1972Q1 to 1995Q4, and the model is estimated using ordinary least squares (OLS). The estimated model is presented below as equation 2.[42]

$$\underset{(t)^*}{\dot{C}u - \dot{P}} = \underset{(-3.3)}{-0.24} + \underset{(14.0)}{0.83}\sum_{i=1}^{5}(\dot{C}u_{-i} - \dot{P}_{-i}) + \underset{(4.4)}{0.14}\dot{Y} + \underset{(2.7)}{0.084}\dot{Y}_{-1} - \underset{(-8.5)}{0.71}\sum_{i=1}^{5}\Delta r_{-i}$$
$$- \underset{(-8.7)}{1.7}\sum_{i=1}^{3}\Delta\dot{P}_{-i} + \underset{(2.8)}{0.12}\sum_{i=2}^{5}\Delta\tau_{D_{-i}} + \underset{(4.8)}{0.16}\sum_{i=4}^{7}\Delta\tau_{I_{-i}} + \underset{(1.6)}{0.19}Dummy_{GST}$$
$$+ \underset{(2.6)}{0.2}(\dot{P}^{C}_{T_{-1}} - \dot{e}_{-1} - \dot{P}^{US}_{T_{-1}}) \qquad (2)$$

Notes: $CR^2 = 0.86$; D.W. = 2.06; $\sigma = 0.38$; LM(1,2)** = 0.68,0.72; Arch(1,2)** = 0.23,0.17; Ramsey(2,3)** = 0.24,0.36

*t statistics in parentheses. ** The numbers indicate the probability value.

All the coefficients have the expected sign and are statistically different from zero at least at a 5 percent critical level, except for the GST dummy, which is significant only at an 11 percent critical level.[43] Direct and indirect taxes have a

41 Bruce Flexman, "Canadian Attitudes Towards Taxation," in Owen Lippert and Michael Walker, eds., *The Underground Economy: Global Evidence of Its Size and Impact* (Vancouver: Fraser Institute, 1997), 35-74.

42 The coefficient values reported on the terms with summation correspond to the sum of coefficients for the distributed lags. Note also that the variables are denoted in percent rate of change, which is equivalent to the first difference of the logarithm.

43 Alternatively, we have also tested dummy variables equal to one for the periods 1991, 1991-1992, and 1991-1993, and zero otherwise.

significant impact on the demand for currency after some lags. The impact of relative tobacco prices is also statistically significant after one lag, as explained by the rapid growth in tobacco smuggling between 1987 and 1993.

The result on the GST dummy appears to be in contrast with Spiro,[44] who claims that the introduction of the GST was responsible for the growth in the underground economy in the early 1990s. But Spiro's approach can be criticized on various grounds. For example, his currency demand equation does not include any tax variable. Therefore, the unexplained rise in the demand for cash in Spiro's model could be explained by factors other than the GST, such as the change in direct taxes or the growth in tobacco and alcohol smuggling. The result in this paper is more in line with Hill and Kabir, who found that the replacement of the manufacturers' sales tax by the GST had a negligible effect on currency demand and on the underground economy.[45]

The Lagrange multiplier (LM) test rejects the presence of autocorrelation of the error term. The possibility of heteroscedasticity is also rejected by the Arch test. In addition, the Ramsey, CUSUM, and CUSUM of square tests all reject the possibility of specification error or instability in the coefficients.

We have also tested alternative specifications of the currency demand equation. In the first alternative model (equation 3), we have incorporated the change in tobacco exports as a proportion of the total tobacco production ($\Delta X_T/Q_T$), rather than the relative price of tobacco products, to capture the effect of tobacco contraband on currency demand. This measure must be considered with caution, however, since it also includes the legal value of exports but excludes the value of illegal imports of US-blend cigarettes.[46] In the second alternative model (equation 4), we have also added the real exchange rate as a separate variable. (The estimation results of equations 3 and 4 are shown in appendix B, table B.1, along with the results of equation 2.) It can be argued that cross-border shopping, motivated in large part by the exchange rate appreciation, might have affected Canadian currency demand independently of its effects on tobacco smuggling. It must be noted, however, that the direction of the effect on currency demand is unclear. If Canadians use Canadian dollars to purchase goods and services in the United States, a real exchange rate appreciation is expected to raise the demand for cash. If, on the other hand, Canadians buy US dollars for cross-border shopping, an exchange rate appreciation is expected to lower the demand for cash.

In equation 3, the coefficient on the change in tobacco exports has the right sign and is statistically significant from zero at a 5 percent degree of significance

44 Supra footnote 40.

45 Roderick Hill and Muhammed Kabir, "Currency Demand and the Growth of the Underground Economy in Canada, 1991-1995" (2000), vol. 32, no. 2 *Applied Economics* 183-92.

46 The estimates of Gervais, supra footnote 2, are available only on an annual basis and cannot be used in this model, which uses quarterly data.

after one lag. The coefficient values of the other variables are also similar to the result obtained in equation 2. In equation 4, the coefficient on the real exchange rate is negative and significant at a 10 percent degree of confidence, meaning that an appreciation of the real exchange rate lowers the demand for cash. In addition, its inclusion in the model does not affect the other coefficient values in the equation when compared with equation 2.

Table 2 presents the measure from Statistics Canada of the annual contribution of tobacco contraband to consumer spending and GDP between 1987 and 1994. These estimates are based on exports of Canadian-blend cigarettes and have been revised since Gervais first published estimates for 1992 and 1993. According to table 2, the consumption of tobacco contraband from Canadian-blend cigarettes grew rapidly during this period, from about Cdn. $32 million in 1987 to Cdn. $1,888 million in 1993, and then fell dramatically in 1994, to Cdn. $343 million, following the tobacco tax cut of February 1994.

But because contraband cigarettes are imported back to Canada and we subtract the value of imports, the net impact of tobacco smuggling on GDP (the net income of smugglers) is much smaller than the impact on consumption. In 1993, for example, 67 percent of the consumption of tobacco contraband represented imports. The impact on GDP is estimated to be Cdn. $624 million, or 33 percent of the estimated impact on consumption.

Although the largest share of tobacco smuggling comes from exports of Canadian-blend cigarettes, there is evidence that, beginning in 1990, US brands began to constitute a non-negligible share of the contraband market. Lindquist Avey Macdonald Baskerville Inc.[47] estimates that US brands accounted for 4.4 percent of the market in 1990, 9.8 percent in 1991, and 6.6 percent in 1992. These numbers may be conservative, given the evidence from custom seizures, which were indicating that the proportion of US-blend seized was about 17 percent in 1992. Gervais also provides an estimate of the contraband imports of US-blend cigarettes, ranging from $107 million in 1989 to $259 million in 1993. These numbers are included in table 2.

The next step is to estimate the demand for cash that is explained by tobacco contraband. Equation 2 is simulated with the relative tobacco price unchanged from its 1986 level. We suppose that tobacco contraband was too marginal before 1986 to be measurable.[48] The estimate of the demand for "nico" dollars from equation 2 is presented in table 3. According to the estimates, this "excess" demand for cash moved from $11 million in 1987 to about $600 million in 1993, representing 2.6 percent of the total currency holding for that year. The demand

47 Supra footnote 5 and supra footnote 29.

48 It must be noted that the model tends to confirm this assumption. Before 1986, the relative tobacco price was fairly constant; it therefore contributes very little to the demand for cash according to equation 2.

Table 2 The Impact on Personal Expenditures and GDP of Tobacco Contraband

	1987	1988	1989	1990	1991	1992	1993	1994
					$ millions			
Canadian-blend[a]								
Consumption[b]	32	42	127	168	687	1,129	1,888	343
Imports	19	25	76	101	412	654	1,264	206
GDP	13	16	51	67	275	475	624	137
US-blend[c]								
Consumption[b]	0	0	107	268	154	216	259	47[d]
Imports	0	0	107	268	154	216	259	47[d]
GDP	0	0	0	0	0	0	0	0
Total cigarettes								
Consumption[b]	32	42	234	436	841	1,345	2,147	390
Imports	19	25	183	369	566	870	1,523	253
GDP	13	16	51	67	275	475	624	137

[a] Statistics Canada. [b] Consumption is the sum of imports and GDP. [c] Gylliane Gervais, *The Size of the Underground Economy: A Statistics Canada View*, Statistics Canada catalogue no. 13-603E, no. 2 (Ottawa: Statistics Canada, 1994). [d] It is assumed to represent the same share of the contraband market as in 1993.

for "nico" dollars fell rapidly after 1993 (representing less than $100 million by the end of 1995, although this is not shown in table 3).

In addition to the estimated demand for "nico" dollars, we also calculate the ratios of income (or GDP) to cash and consumption to cash for tobacco contraband. As shown in table 3, the income-to-cash ratio is very small, ranging between 0.3 and 1.2, and averaging 0.7. The consumption-to-cash ratio is much higher, ranging between 1.0 and 3.6, with an average value of 2.2. These estimates are at the low end of the range of values used in most studies to estimate the size of the underground economy. On the other hand, they are much closer to the income velocity of M2 and M2+. They are also within the range of the income velocity of cash estimated by Klovland[49] and the value used by Cagan.[50] The low value for this income-to-cash ratio also supports the view from considerable anecdotal evidence that cash hoarding is prevalent among tobacco smugglers.

As a measure of sensitivity, we have done a similar simulation exercise with equation 3. According to this alternative result, the change in tobacco exports has a smaller impact on the demand for currency, compared with the result for equation 2. For example, the impact on currency demand is about half as large in 1989 and 1990, but rises quickly thereafter, reaching $330 million in 1994 compared with $401 million in the original result. This large difference in 1989 and 1990 is explained by the fact that equation 3 excludes the effect of US-blend

49 Supra footnote 3.

50 Supra footnote 7.

Table 3 Estimated Currency Demand Associated with Tobacco Contraband

	1987	1988	1989	1990	1991	1992	1993	1994	Mean
					$ millions				
Currency demand (Cu)	11	44	106	199	341	516	603	401	288
					percent				
Percent of total Cu	0.07	0.26	0.59	1.06	1.72	2.43	2.62	1.62	1.30
					ratio				
Consumption-to-cash ratio	2.9	1.0	2.2	2.2	2.5	2.6	3.6	1.0	2.2
Income-to-cash ratio	1.2	0.4	0.5	0.3	0.8	0.9	1.0	0.3	0.7

cigarettes on currency demand. As can be calculated in table 2, US-blend cigarettes represented 46 percent of tobacco contraband in 1989 and 61 percent in 1990, compared with an average of only 15 percent during the 1991 to 1993 period. The result from table 2 implies that the change in the demand for US-blend cigarettes was not proportional to the change in the demand for Canadian-blend cigarettes. It also suggests that, as the supply of Canadian cigarettes increased in the contraband market in the early 1990s, Canadian smokers substituted US-blend for Canadian-blend cigarettes. Finally, since equation 3 cannot properly capture the effect of US-blend cigarettes, this result must be interpreted with care. However, when we calculate the consumption-to-cash ratio with the result of equation 3 and exclude the consumption of US-blend cigarettes, the value of the ratio averages 2.4, which is similar to the average ratio of 2.2 estimated with equation 2.

From the regression estimate and the consumption-to-cash ratio, we can estimate the sensitivity of tobacco contraband to a change in the relative price of tobacco products. First, we calculate the long-run elasticity of the demand for cash with respect to the relative price of tobacco. This is equal to

$$0.2 / (1 - 0.83) = 1.176$$

Second, to convert this into a measure of the sensitivity of tobacco contraband to the relative price of tobacco, we multiply 1.176 by the mean of the consumption-to-cash ratio, 2.2, which is equal to 2.6. This result can be interpreted as follows: a 1 percent rise in the price of Canadian tobacco products relative to US tobacco prices would be followed by a 2.6 percent increase in the consumption of tobacco contraband, assuming that everything else remained unchanged.

The next question is, can this provide some insight about the value of the income-to-cash ratio for the rest of the underground economy?

If we assume that tobacco smugglers have a similar rate of time preference and the same degree of risk aversion as other agents who work in the underground economy, there is a good chance that their income-to-cash ratio will also be similar.

One can argue, however, that the cash requirement is different for tobacco smuggling than for other types of underground activities. Smuggling first involves

large amounts of cash among exporters, importers, and wholesalers. Then it requires small amounts of cash at the retail level. Therefore, while we can probably suppose that the cash requirement in other smuggling activities, such as alcohol contraband and drug dealing, is similar to that in tobacco contraband, certainly not all individuals who underreport income operate like smugglers and drug dealers. In some sectors, for example, the underground economy consists of underreporting of sales by otherwise legitimate businesses, representing only a small portion of their activities. Such activity probably entails less currency hoarding. In addition, other underground activities are less likely to be as import intensive as tobacco smuggling, implying that the value of consumption is closer to the net value of income.

Therefore, the income-to-cash ratio in tobacco contraband is probably a good indicator of the income-to-cash ratio in overall smuggling and criminal activities, but could understate it for other underground sectors. Nevertheless, the above results suggest that the income-to-cash ratio in the total underground economy is likely much smaller than suggested in a number of studies. Klovland[51] suggests a value of about 3, based on an estimate of the income velocity of cash in the Netherlands, and Spiro[52] suggests a value of 5 for Canada. These suggestions imply that the income-to-cash ratio in the rest of the underground economy is more than three to five times larger than in total smuggling and criminal activities.

An alternative suggestion is to use a range from 1 to 5. A value of 5 is likely too high, since it would overstate the size of tobacco contraband by more than five times, based on the results of equation 2, and possibly also overstate other smuggling and criminal activities. Also, as argued earlier, a value of 1 is likely too low for other underground activities. As a result, it may be more reasonable to narrow the range further, say between 2 and 3, which is between the income velocity of M2 in Canada and the income velocity of cash as estimated by Cramer for the Netherlands.[53]

If, indeed, the income-to-cash ratio in the underground economy is somewhere between 2 and 3, it would imply that most previous estimates from the currency demand approach significantly overestimate the size of the underground economy. A reevaluation of these studies with a ratio of between 2 and 3 would provide estimates on the size of the underground economy closer to lower-bound estimates. For example, Klovland's estimate[54] for Sweden in 1982 would be between 3 percent and 8.5 percent of GDP, with an income-to-cash ratio of between 2 and 3, compared with 20 percent, with a ratio of 7. Spiro's estimate[55] for Canada would move down from between 8 percent and 11 percent of GDP in 1993 to between

51 Supra footnote 3.

52 Supra footnote 23.

53 Supra footnote 17.

54 Supra footnote 3.

55 Supra footnote 23.

3.2 and 9 percent. Hill and Kabir[56] would show between 2.8 percent and 4.2 percent for the change in the underground economy in Canada between 1964 and 1995, compared with 11.2 percent, with a ratio of 7.

A lower range would also help to reconcile estimates of the size of the underground economy from the currency demand approach with estimates from other methods, such as the survey methods and sensitivity analyses in the US National Income Accounts and Canadian National Accounts. For example, Spiro's and Hill and Kabir's estimates for Canada would be closer to those of Gervais[57] and Fortin et al.[58] A similar evaluation can also be made for estimates of the size of the underground economy done in other countries.

CONCLUSION

We have seen that the great uncertainty surrounding the measure of the income-to-cash ratio in the underground economy reduces our ability to rely on the currency approach to estimate the size of the underground economy. In this paper, we use the episode of the expansion of tobacco contraband in Canada over the period 1987 to 1993 as a natural experiment to estimate the demand for "nico" dollars, to calculate the income-to-cash ratio in that sector of the underground economy, and to measure the sensitivity of the tobacco contraband to the relative price of tobacco products.

According to our findings, the demand for cash associated with tobacco contraband represented up to 2.6 percent of the total currency demand in Canada in 1993. The results also indicate that the income-to-cash ratio is fairly low, suggesting a high degree of currency hoarding in that sector. Moreover, we find that, as expected, tobacco contraband is very price sensitive. A 1 percent rise in Canadian tobacco prices would raise the consumption of tobacco contraband by 2.6 percent.

Assuming that the estimate of the income-to-cash ratio in tobacco contraband mirrors the income-to-cash ratio in other smuggling and criminal activities, the results support the view that it is probably inappropriate to use the income velocity of M1, and that a lower value is preferable. The results also support Cagan's[59] and Klovland's[60] presumption that the degree of currency hoarding in the hidden sector is greater than in the regular sector, at least in the case of tobacco contraband. In addition to suggesting a lower value, we propose using a narrower range for the income-to-cash ratio to estimate the size of the underground economy.

---

56 Supra footnote 3.

57 Supra footnote 2.

58 Bernard Fortin, Gaétan Garneau, Guy Lacroix, Thomas Lemieux, and Claude Marquette, *L'économie souterraine au Québec : ampleur et caractéristiques* (Montréal: Cirano, 1995).

59 Supra footnote 7.

60 Supra footnote 3.

Finally, this article attempts to reconcile the results from various methods. It argues that the large discrepancy between estimates of the underground economy from the currency approach and from survey methods may in part be explained by a measure of the income velocity of cash, which has generally been too high.

APPENDIX A SUMMARY OF STUDY RESULTS ON THE SIZE OF THE UNDERGROUND ECONOMY

Table A.1 Studies Using the Currency Demand Approach

Study	Country	Measure of velocity	Estimate (% of GDP or GNP)
Schneider 1986[a]	Denmark	Legal M1	7-12% in 1978-1982
Schneider 1994[b]	Austria	Legal M1	5.3% in 1991
Schneider 1998[c]	17 OECD countries	Legal M1	From 6.6% in Switzerland to 25.8% in Italy in 1994
Tanzi 1980[d]	United States	Legal M1	3.4% to 11.7% in 1976
Tanzi 1983[e]	United States	Legal M1	4.5% to 6% in 1980
Spiro 1994[f]	Canada	5	8% to 11% in 1992
Éthier 1985[g]	Canada	M1	5.7% in 1981
Hill and Kabir 1996[h]	Canada	2 to 7	2.8% to 11.2% in 1995[i]
Klovland 1984[j]	Sweden	2 to 7	3% to 20% in 1981
Langfeldt 1984[k]	West Germany	Legal M1	12.6% in 1980
Isachsen and Strøm 1985[l]	Norway	Legal M1	6.3% in 1978

[a] Friedrich Schneider, "Estimating the Size of the Danish Shadow Economy Using the Currency Demand Approach: An Attempt" (1986), vol. 88 *Scandinavian Journal of Economics* 643-68. [b] Friedrich Schneider, "Can the Shadow Economy Be Reduced Through Major Tax Reform? An Empirical Investigation for Austria" (1994), vol. 49, supplement *Public Finance* 137-48. [c] Friedrich Schneider, "Further Empirical Results of the Size of the Shadow Economy of 17 OECD Countries Over Time," paper presented at the Canadian Public Economics Study Group, May 27, 1998, Ottawa. [d] Vito Tanzi, "The Underground Economy in the United States: Estimates and Implications" (December 1980), 135 Banca Nazionale del Lavaro *Quarterly Review* 427-53. [e] Vito Tanzi, "The Underground Economy in the United States: Annual Estimates, 1930-1980" (1983), vol. 30, no. 2 *International Monetary Fund Staff Papers* 283-305. [f] Peter S. Spiro, "Estimating the Underground Economy: A Critical Evaluation of the Monetary Approach" (1994), vol. 42, no. 4 *Canadian Tax Journal* 1059-81. [g] Mireille Éthier, "The Underground Economy: A Review of the Economic Literature and New Estimates for Canada," in François Vaillancourt, research coordinator, *Income Distribution and Economic Security in Canada*, Collected Research Studies of the Royal Commission on the Economic Union and Devlopment Prospects for Canada, vol. 1 (Toronto: University of Toronto Press, 1985), 77-104. [h] Roderick Hill and Muhammed Kabir, "Tax Rates, the Tax Mix, and the Growth in the Underground Economy in Canada: What Can We Infer?" (1996), vol. 44, no. 6 *Canadian Tax Journal* 1552-83. [i] Change in the underground economy since 1964. [j] Jan Tore Klovland, "Tax Evasion and the Demand for Currency in Norway and Sweden: Is There a Hidden Relationship?" (1984), vol. 86 *Scandinavian Journal of Economics* 423-39. [k] Enno Langfeldt, "The Unobserved Economy in the Federal Republic of Germany," in *The Unobserved Economy* (Cambridge: Cambridge University Press, 1984), 236-60. [l] Arne Jon Isachsen and Steiner Strøm, "The Size and Growth of the Hidden Economy in Norway" (1985), vol. 31 *Review of Income and Wealth* 21-38.

Table A.2 Studies Using Other Methods

Study	Country	Method	Estimate (% of GDP or GNP)
Isachsen, et al. 1982[a]	Norway	Household survey	2.3% in 1980
Isachsen and Strøm 1985[b]	Norway	Household survey	2% in 1983
Fortin, et al. 1995[c]	Canada (Quebec)	Household survey	1.9% to 2.5% in 1992
Fortin, et al. 1987[d]	Canada (Quebec)	Household survey	0.9% to 1.4% in 1986
Gervais 1994[e]	Canada	National Accounts	3.7% in 1992 in the National Accounts; 5.2% for taxable income
Berger 1986[f]	Canada	National Accounts	2.8% in 1981
Feige 1980[g]	United States	Transactions	27% in 1979
Mirus, et al. 1994[h]	Canada	Transactions	19.3% in 1984

[a] Arne Jon Isachsen, Jan Tore Klovland, and Steiner Strøm, "The Hidden Economy in Norway," in Vito Tanzi, ed., *The Underground Economy in the United States and Abroad* (Lexington, Mass.: Lexington Books, 1982), 209-31. [b] Arne Jon Isachsen and Steiner Strøm, "The Size and Growth of the Hidden Economy in Norway" (1985), vol. 31, no. 1 *The Review of Income and Wealth* 21-38. [c] Bernard Fortin, Gaétan Garneau, Guy Lacroix, Thomas Lemieux, and Claude Marquette, *L'économie souterraine au Québec : ampleur et caractéristiques* (Montréal: Cirano, 1995). [d] Bernard Fortin, Pierre Fréchette, and Joëlle Noreau, *Premiers résultats de l'Enquête sur les incidences et les perceptions de la fiscalité dans la région de Québec : dimensions et caractéristiques des activités non-déclarées à l'impôt*, Cahier 8702, Cahiers d'aménagement du territoire et du développement régional, 1987. [e] Gylliane Gervais, *The Size of the Underground Economy: A Statistics Canada View*, Statistics Canada catalogue no. 13-603E, no. 2 (Ottawa: Statistics Canada, 1994). [f] Seymour Berger, "The Unrecorded Economy: Concepts, Approach and Preliminary Estimates for Canada, 1981," in *Canadian Statistical Review, April 1986*, Statistics Canada catalogue no. 11-003, 1-125. [g] Edgar L. Feige, "A New Perspective on Macroeconomic Phenomena: The Theory and Measurement of the Unobserved Sector of the United States—Causes, Consequences and Implications" (mimeograph, Netherlands Institute for Advanced Study, Wassenar, 1980). [h] Rolf Mirus, Roger R. Smith, and Vladimir Karoleff, "Canada's Underground Economy Revisited: Update and Critique" (1994), vol. 20, no. 3 *Canadian Public Policy* 235-52.

APPENDIX B ESTIMATED MODELS

Table B.1 Primary and Alternative Specifications of the Currency Demand Equation

	Equation 2	Equation 3[a]	Equation 4[a]
Variables			
Constant	−0.24	−0.21	−0.24
	(−3.3)[b]	(−3.1)	(−3.5)
$\sum \dot{C}u_{-i} - \dot{P}_{-i}$	0.83	0.81	0.83
	(14.0)	(13.7)	(14.1)
$\dot{Y}$	0.14	0.13	0.14
	(4.4)	(4.2)	(4.4)
$\dot{Y}_{-1}$	0.084	0.08	0.08
	(2.7)	(2.6)	(2.7)
$\sum \Delta r_{-i}$	−0.71	−0.73	−0.72
	(−8.5)	(−8.6)	(−8.6)
$\Delta \dot{P}_{-i}$	−1.7	−1.7	−1.7
	(−8.7)	(−8.8)	(−8.9)
$\sum \Delta \tau_{D-i}$	0.12	0.13	0.12
	(2.8)	(2.9)	(2.8)
$\sum \Delta \tau_{I-i}$	0.16	0.14	0.16
	(4.8)	(4.4)	(4.9)
$Dummy_{\text{GST}}$	0.19	0.12	0.14
	(1.6)	(1.0)	(1.2)
$\dot{P}^{C}_{T-1} - \dot{e}_{-1} - \dot{P}^{US}_{T-1}$	0.2		0.22
	(2.6)		(2.8)
$100 * \Delta X_{T-1} / Q_{T-1}$		0.027	
		(2.4)	
$\dot{P} - \dot{e} - \dot{P}^{US}$			−0.041
			(−1.8)
Statistical tests			
CR^2	0.86	0.86	0.86
D.W.	2.06	2.0	2.1
σ	0.37	0.38	0.37
SSR	11.8	11.9	11.4

[a] The dynamic structure of equations 3 and 4 is the same as that of equation 2. [b] *t* statistics are in parentheses.